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# Southern occurrence of the sand sole (*Psettichthys melanostictus*).

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The geographic and depth ranges of marine fishes commonly reflect their physiological preferences (Pörtner et al., 2010). Given the wide availability of habitats along the California coastline, biogeographic range extensions of many species have been observed to occur periodically, most frequently during periods of short-term oceanographic temperature fluctuation. Over the last 30 years, these range extensions in California have mostly been poleward expansions as ocean temperatures have warmed or through large-scale oceanographic anomalies such as Californian-El Niño conditions (Lea and Rosenblatt, 2000). Many of the recently documented range extensions in southern California have been associated with thermal power plant cooling water intakes or discharges, often due to the increased sampling and/or the presence of greater-than-ambient water temperatures near the discharges (Pondella, 1997; Lea and Rosenblatt, 2000; Miller and Curtis, 2008). In addition to the thermal discharge, the cooling water system entrains material, including fishes, with the cooling water drawn into the system. The cooling water is filtered through traveling screens with a nominal square mesh of 10-mm to prevent debris from passing farther into the system and potentially clogging downstream condensers. Fish impingement upon these traveling screens is routinely monitored to provide a representative accounting of the fishes taken in by the cooling water system, and an opportunity to collect random tourist species.

Sand sole (*Psettichthys melanostictus*) reportedly ranges from the Southeastern Bering Sea, Alaska to Newport Beach, California in depths ranging from the intertidal zone out to 325 m (Love et al., 2005). Museum records contain numerous specimens taken in northern California with only three lots collected offshore of Ventura County, California at the southernmost extent (Fishnet2 2011). Surprisingly, no records were found for collections in the Santa Barbara, California area despite substantial areas of suitable habitat. Reviews of the Santa Barbara Natural History Museum (SBNHM 2011) ichthyology records found no sand soles in the collection. Fitch and Schultz (1978) detailed two fish taken in the southern Santa Monica Bay in the mid-1970s during impingement sampling at Scattergood Generating Station in El Segundo, California and the Redondo Beach Generating Station in Redondo Beach, California. The Redondo Beach sample had set the southern range limit for this species at the time. Slightly farther southwards, several sand sole were caught by recreational anglers fishing off the Balboa Pier during the 1980s (M. Love, unpubl. data), which had served as the impetus for the current southern range endpoint. One collection that has gone largely unreported is recorded in the Museum of Comparative Zoology (MCZ 2011) as collected in San Diego County, California during the mid-1800s (Lot 25988) and has not been previously included in the biogeographic distribution of the sand sole (Love et al., 2005; Horn et al., 2006). This sample, however, has limited information regarding its collection. Careful

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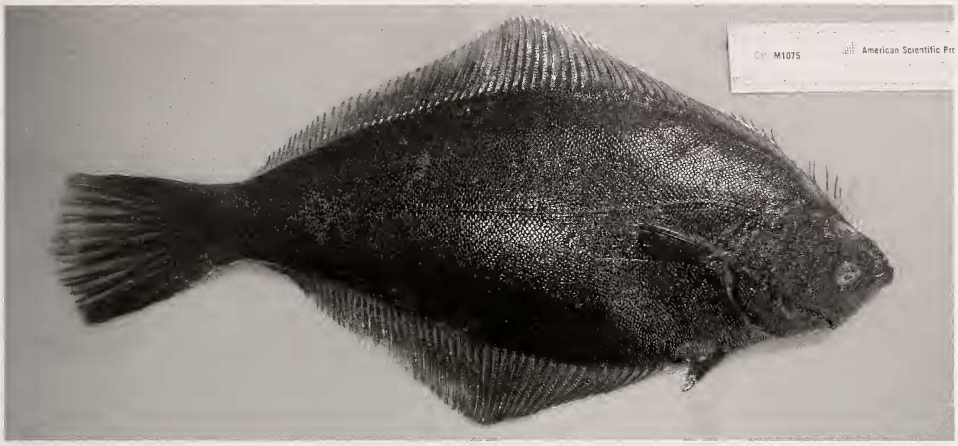


Fig. 1. Photo of a sand sole collected at the San Onofre Nuclear Generating Station near San Clemente, California on March 22, 2011. The specimen measured 235 mm SL and weighed 212 g.

review of the available record indicates the sample is now missing and was originally held in a jar with other lots collected near San Francisco, California (Lots 11197 and 11559) that each contain extensive collection information. The status of this San Diego record raises concerns as to its validity given the lack of collection information, unknown present status of the specimen, and its historic storage with San Francisco collections.

While these records hardly represent its population size in the area, it does signify the rarity of its occurrence in the Southern California Bight. A demersal species, it has yet to be taken in either of the four completed summer regional otter trawl surveys conducted by the Southern California Coastal Water Research Project (E. F. Miller, pers. obs.) or in various otter trawl monitoring surveys conducted on a near annual basis since 1972 throughout portions of the Southern California Bight in support of regulated discharge monitoring (Stull and Tang, 1996).

The San Onofre Nuclear Generating Station Unit 2 withdraws seawater through an open-water intake located 950 m offshore along the 10-m isobath at 33° 21.633′N, 117° 33.743′W. On March 22, 2011, R.H. Moore collected a 235-mm SL sand sole that weighed 212 g (Figure 1) during an impingement survey. The identification was made based on the occurrence of five free dorsal rays, consistent with the diagnostic features described by Miller and Lea (1976) and confirmed with local taxonomic experts (H.J. Walker, pers. comm.[2]; R.N. Lea, pers. comm.[3]; M.L. Love). This specimen has been deposited with the Scripps Institution of Oceanography Marine Vertebrate Collection with catalog number SIO 11–74.

We note that the San Onofre fish represents the most southerly physical collection of this species. However, on 3 September 2009, a specimen was photographed *in situ* in the La Jolla Shores area (at about 32° 51.3′N, 117° 15.2′W) at a depth of about 20 m by David Andrews (Figure 2). The identity of this specimen was confirmed by M.L. Love based on the dorsal fin ray separation. Thus the documented range of the sand

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Fig. 2. Image of sand sole observed in the La Jolla Shores, California area at a depth of ~ 20 m taken on September 3, 2009 by D. Andrews with the identity confirmed by M. L. Love.

sole has been extended/reconfirmed southwards approximately 105 km from Newport Beach to La Jolla Shores, California. This may represent the second record from the San Diego County, California area separated by over 100 years if the aforementioned mid-1800s specimen catalogued in the Museum of Comparative Zoology is considered, but, again, the earlier sample is unconfirmed and questionable given the caveats detailed above.

Recent southern extensions or occurrences have been noted less frequently given the recent poleward trend in biogeographic shifts (Lea and Rosenblatt, 2000; Perry et al., 2005; Harley et al., 2006), but the recent decline in seawater temperatures (Figure 3) may have made southern extensions, such as this, physiologically possible. Mean annual sea surface temperatures (SST) recorded at the San Clemente Pier in San Clemente, California, approximately 8 km northwest of the San Onofre Nuclear Generating Station, through September 30, 2010 were the third coolest since 1990 and the 16$^{th}$ coolest since 1966 (UCSD 2011). With the exception of 2004 and 2009, the mean annual SST since 2000 at San Clemente has remained below 17.5°C after generally exceeding this for the prior 17 years. If oceanographic conditions continue as they have persisted for the recent five years, it is expected that additional southern range extensions will be recorded.

## Acknowledgements

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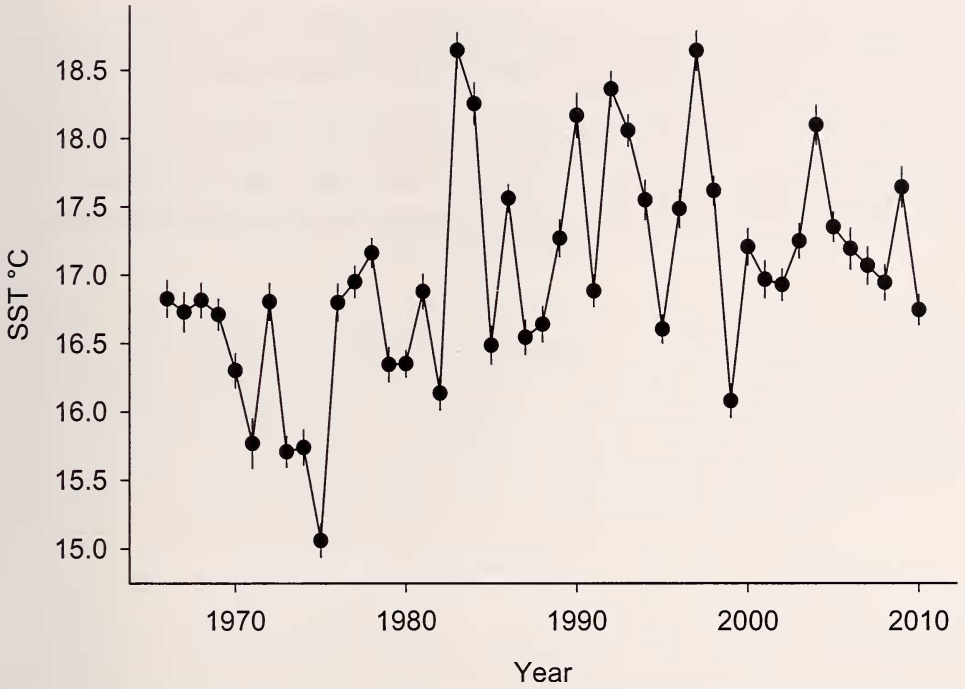


Fig. 3. Mean daily sea surface temperature (°C) recorded at the San Clemente Pier, San Clemente, California, approximately 8 km northwest of the San Onofre Nuclear Generating Station, January 1, 1966 – September 30, 2010.

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